



### Exhibit message

Some snakes, such as pythons, boas, vipers and pit vipers (e.g. rattlesnakes) have heat sensory pits that detect the body heat of nearby prey. This can be effective at night time, when the snake cannot see very well.

### Quick fact

Dead and even decapitated rattlesnakes have been reported to bite humans, possibly due to a reflex action. It is recommended that rattlesnakes should be left alone for 60 minutes after being killed to avoid being bitten.

Vampire bats which search for warm-blooded prey and suck their blood also seem to be able to detect infrared radiation.

### Graphic panel text

You can't hide in the dark when you radiate body heat!

Some snakes hunt at night by sensing the body heat of prey 5–15 centimetres away.

Heat receptors called pit organs are found on the heads of pit vipers, pythons, boas, king and gopher snakes.

The pits are lined with heat-detecting nerves known as thermoreceptors.

When the range of two pits overlaps, the snake detects heat images in stereo. This helps them to strike at prey accurately in the dark.

### Want to know more about infrared pit organs?

Pit organs on snake faces are thought to detect either body heat or infrared radiation that is given off by warm bodies. These warm bodies include prey, threatening attackers and even a warm place to hibernate.

Humans can see coloured light from violet (which has a short wavelength), through to blue, green, yellow, orange and red light (which has a long wavelength). Radiation that is longer in wavelength than red light is known as infrared radiation.

Very hot objects radiate yellow, orange and red light that humans can see and infrared radiation that humans cannot see. Warm objects may not radiate red, yellow or orange light, but they still emit infrared radiation.

Scientists are debating whether snakes with pit organs can detect the infrared radiation or the actual radiant heat given off by warm bodies. These warm bodies don't need to be really hot, but they need to be warmer than the surrounding air temperature.

Pit organs are found on the faces of pythons, boa constrictors, and vipers such as rattlesnakes. These snakes belong to the families Boidae (pythons and boas known as boids) and Crotalinae (vipers such as rattlesnakes, copperheads and cottonmouths). Other snakes do not have pit organs.

These heat-detecting snakes mostly feed on birds and mammals that generate their own body heat (endotherms). The eyes and ears of rodents are warmer than the rest of their body, which may explain why some crotalines prefer to strike at a rodent's head rather than its body.

Both day (diurnal) and night-active (nocturnal) boids are thought to use their pit organs at the same time as their vision. Nocturnal boids may rely more on their pit organs, because it is difficult to see at night time.

Snakes generally have around 20 pit organs, lined up along the upper and/or lower lips. The size and number of pit organs varies between snakes. How well a snake can detect prey using its pit organs would vary between different species of snake.

During the day, heat-sensing snakes shift smoothly between vision (eyes) and infrared (pit organs) when striking prey. As well as using vision and heat detecting capabilities, these snakes 'taste' the air to smell nearby prey and sense vibrations through the ground.



Snakes use their pits to compare background or atmospheric heat and the heat being given off by prey. They do not 'measure' the body temperature of prey. Just as humans find it difficult to see things in bright sunlight glare, snakes must distinguish between the prey's warm body and the background heat.

### Extra for experts

Snakes go through certain stages as they hunt and they use multiple senses of vision, heat-detection, smell and vibration-detection.

Crotalines and pythons mostly use vision in the early hunting phases (head turning and approach). In the later phases of preparation and strike, infrared or thermal information becomes more important to the snake, while visual information is still used, but becomes less important.

Brain cells in snakes that process information from the pit organs are near brain cells receiving signals coming from the eyes. Nerves from the snake's eyes and pit organs connect directly to the snake's brain stem (pre-motor) and indirectly to the spinal cord (motor area), where axial muscles involved in the strike attack might be activated.

Some brain cells seem to respond equally well to infrared and visible light. Infrared detection may reinforce what a snake sees (even at night when the snake's vision is lowered).

Scientists have different theories about how pit organs sense warm bodies:

1. Nerves in the pit organs detect infrared in a similar way to human eyes detecting visible light, or
2. Thermoreceptors in the pit organ membrane are stimulated by temperature, just as human skin can detect hot or cold objects.

It is also possible that the pit organs absorb infrared radiation and this absorbed energy causes the pit organ itself to heat up.

Nerve endings in the pits seem to be constantly firing, and they discharge more frequently when a warm body is placed in front of the snake.

Snakes seem to be able to detect objects almost half a metre away when they are very hot (such as a soldering iron or glowing light bulb filament). Objects that are about body temperature (37 °C) emit less energy can only be detected by the snake at shorter distances (5 centimetres or more).

As infrared radiation enters the snake's facial pits, the walls of the pit tend to cast shadows (similar to shadows we see during daylight). These shadows may allow the snake to pinpoint which direction the prey is located, how far away it is and whether the prey is moving or stationary.

Infrared radiation coming from prey in front of the snake strikes the back of the snake's pits and stimulates the frontal regions of the snake's brain. Infrared radiation from prey beside and slightly behind the snake strikes the front of the pits and stimulates brain areas further back in the snake.

The nerve endings in pit organs that detect temperature seem to be more complex than the thermoreceptor nerve endings that detect temperature in human or mammalian skin. Thermoreceptors in mammalian skin are reasonably deep in the skin, while thermoreceptors in snake pit organs are 20 times closer to the surface and thousands of times more dense.

### Further information

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Thermoreceptive Pits  
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